

patients this was so evident that hot and cold douching of the esophagus was resorted to with definite benefit. This was accomplished by passing a small stomach tube into the pouch and alternately filling and aspirating the contents by the use of a hard rubber syringe. By thus washing out the mucus and decomposing food, the passage of the silk thread was facilitated. We have observed patients in whom tenacious milk curds and other foods would be retained for hours or even days. This atonic and dilated state of the esophagus is doubtless as much a part of the affliction as the cardiospasm itself and not simply secondary. It therefore should receive therapeutic consideration from the start. In one of our patients the stricture became so pronounced that not even water would pass through and, of course, neither was the passage of the thread successful. But before resorting to a gastrotomy a very gentle but persevering effort was made to pass a small-sized piano-wire bougie direct. This was passed down to the stricture through a quite stiff stomach tube which was not fenestrated on the side. After a half-hour of teasing, the bougie was successfully passed and, of course, the rest was easy. It should be added that thorough lubrication of the inside of the stomach tube was necessary.

One having much of this work to do should learn to build his own dilating bags which, if designed somewhat after the lines of an hourglass, are more sure to be held firmly in the stricture during the process of dilatation. The suggestion that emphasis should be placed upon building up the general nerve and muscle tone and nutrition of the patient is important.

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KENNETH S. DAVIS, M. D. (Saint Vincent's Hospital, Los Angeles).—The chief roentgenographic characteristics of typical cardiospasm are the smooth, symmetrical, blunt or conical obstruction at or near the cardia and the secondary dilatation of the esophagus above. This dilatation is usually marked; in some instances involving the entire esophagus. In cases of long duration the esophagus is usually somewhat elongated and may become either kinked or S-shaped. Thus we find the spindle-shaped, the pear-shaped, and the S-shaped types of dilated esophagus as described in the article under discussion.

Reversed peristalsis may be seen during the fluoroscopic examination; this finding, however, is very rare. Quite commonly the dilated esophagus is found to be filled with fluid through which the opaque barium slowly sinks in blobs.

From the roentgenographic viewpoint cardiospasm is to be differentiated chiefly from carcinoma and benign organic stricture. Carcinoma seldom ends exactly at the hiatus and there is usually noted an irregularity of the lower end of the barium shadow, whereas in cardiospasm the shadow is symmetrical and smooth. Furthermore carcinoma rarely causes the extreme dilatation of the esophagus so commonly seen in cardiospasm. Posttraumatic strictures generally occur higher in the esophagus than the cardia, and one can reasonably expect some irregularity at the site of the lesion. As Hara has already pointed out, an inquiry should be made as to the swallowing of corrosives in all suspected cases.

In view of the fact that filling defects at the site of the obstruction do not always signify organic lesion, and smooth, symmetrical regularity always indicate cardiospasm, great care should be taken to carefully coördinate the clinical and the roentgenographic findings. Esophagoscopy should be done in any case with indefinite clinical and roentgenographic findings.

The author states that gastrotomy should be performed in cases of cardiospasm in which bougies cannot be passed. In a large series of cases Vinson has seldom found it necessary to resort to this procedure, due to his success in passing bougies. He does this by first having the patient swallow a thread which, when anchored, serves as a guide for the bougie. By tensing the thread the bougie can be directed exactly

to the constricted area which is then dilated. This method also eliminates danger of perforation.

For the fluoroscopic examination of the esophagus a special barium acacia mixture is commonly used. This mixture is exceedingly viscid and descends the esophagus slowly with a tendency to coat its walls rather than fill the lumen. In this manner filling defects are brought into plain view which ordinarily would be missed.

## ACTINOMYCOSIS\*

### REPORT OF CASES

By NORMAN EPSTEIN, M. D.

AND

PAULA SCHOENHOLZ, M. A.

San Francisco

DISCUSSION by George D. Culver, M. D., San Francisco; H. J. Templeton, M. D., Oakland; Roy W. Hammack, M. D., Los Angeles.

ACTINOMYCOSIS is a well-known clinical entity and has been carefully described in all its details by many observers. The purpose of this report is to summarize some advances which have contributed to a better understanding of the condition, and have led to a more rational plan of treatment. The discussion is limited to actinomycosis of the jaw.

### EARLY STUDIES ON ACTINOMYCOSIS

The view that actinomycosis is contracted by the introduction of such substances as infected grain, straw, and grasses into the oral cavity dates back to the work of Bostroem<sup>1</sup> in 1890. He had isolated a streptothrix from human cases of actinomycosis which was apparently identical with an organism found widespread in nature upon grasses and grains. This theory has been handed down in textbooks and in the lecture room since that time. Homer Wright<sup>2</sup> showed that the true *Actinomyces bovis*, first described by Israel and Wolff<sup>3</sup> in 1878, is not found outside of the animal body and that it has quite different cultural characteristics from the streptothrix of Bostroem. *Actinomyces bovis* is a compulsory anaërobe, difficult to grow, and grown best at body temperature. On the other hand Bostroem's organism grows luxuriantly on ordinary culture media, at room temperature, and is an aërobe.

F. T. Lord<sup>4</sup> in 1910 reported that he had isolated *Actinomyces bovis* from carious teeth and cryptic tonsils in patients who had no evidence of actinomycosis. This work seems to indicate that *Actinomyces bovis* may be a saprophyte which exists in the normal mouth and gastro-intestinal tract.

The source of infection in many cases of actinomycosis has been quite obscure, no history of contact with infected cattle being obtained. Many patients deny that they chew straw or grass or that they have been connected with rural life in any way. From a clinical standpoint it would seem more probable that the organisms exist as

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saprophytes in the mouth and gastro-intestinal tract and become pathogenic when the resistance of the tissues is lowered because of factors such as trauma and infection.

Although actinomycosis is unknown in California, Sanford and Voelker<sup>5</sup> were able to collect six hundred and seventy cases of the disease from the literature and by personal communications. It is found most commonly in the northwestern and middle-western states, but it occurs everywhere in the United States.

Males are affected more commonly than females, 80 per cent and 20 per cent, respectively. It is mainly a disease of youth, most cases occurring between the ages of twenty to thirty, but no age is immune. The disease may attack any tissue or structure of the body. In approximately 60 per cent of the cases the condition begins somewhere about the face and neck, 18 per cent occur in the abdominal wall and viscera, usually starting about the cecum and appendix and from there spreading to the liver. Fourteen per cent are found in the thorax. The bones are rarely involved. Primarily actinomycosis of the skin is quite unusual, the process usually involving the skin secondarily.

#### BACTERIOLOGY

The classification of actinomycosis has been a complicated and a much disputed question. Bostroem, Wolff and Israel, and Affanassjeff consider them bacteria; de Bary, Harz, Gasperini, Sanvagean and Radais place them among the hyphomycetes; while Rossi, Doria, Claypole, Kruse, and Lieske place them between these two groups.<sup>†</sup> On the one hand actinomyces resemble bacteria in size, thread formation, branching and arthrospore formation; on the other hand, hyphomycetes may be distinguished from the actinomyces by the size of the cells, their cell content and lack of radial striations. According to Lieske the actinomyces can be considered phylogenetically as higher bacteria, or reduced thread fungi, or a common antecedent of the bacteria and fungi. The following diagram will explain the relationship of the actinomyces to the fungi and bacteria.

Actinomyces < Oidium, Hyphomycetes  
Mycobacteria, Korynebacteria, Bacteria

Pathogenic as well as saprophytic strains of actinomyces are found widely distributed in nature. It is thought that the saprophytic strains are predominantly aerobic. The pathogenic strains isolated from infected tissue are anaerobic. All the intermediary forms from the long-threaded aerobic to the anaerobic bacillus-like type may be found.

Actinomyces can be readily cultivated on bouillon agar gelatin, milk, blood serum, potatoes, and other media. The reaction should be neutral since strong acid or alkali inhibits growth. Liquid media do not become turbid during growth, but fine white flakes develop along the walls of the tube and settle at the bottom as small white flakes or balls. In deep agar, colonies are irregular and hard. Freezing and sunshine do not injure the

organisms; drying only slightly. They remain alive for five years. Aerobic actinomyces sometimes produce pigment; anaerobic strains do not.

Since pus from the discharging lesion is usually contaminated with aerobic saprophytes great difficulty is encountered in purifying the actinomyces. The strain isolated was cultivated in the following manner: A small amount of the discharged pus was planted into warmed (56 degrees Centigrade) beef heart media previously stratified with sterile vaselin. Another portion of the infected material was placed directly into one per cent glucose veal infusion agar shakes to which one-tenth per cent sterile human blood serum had been added. These tubes were incubated at 37 degrees Centigrade for seven to ten days. Some of them appeared contaminated with staphylococci, but several of the tubes remained clear for the first few days. Gradually white flakes appeared in the beef heart medium along the walls of the tube. During the next three to four days these flakes settled to the bottom in white solid masses. In the deep agar tubes, irregular shaped, cream-colored colonies developed in the depths of the agar. These colonies were removed with the aid of a Pasteur pipette. They were hard and sometimes difficult to remove from the agar. About ten such colonies were picked into fresh beef heart medium. These subcultures did not all develop. However, a good growth was obtained in several of the tubes which, upon microscopical examination and subculturing, appeared to be pure. Aerobic staphylococci were not present.

A vaccine from one of the purified strains was prepared in the following manner: One-tenth per cent sterile human serum was added to one per cent glucose veal broth and stratified with sterile vaselin. The culture was heavily seeded into these tubes and grown at 37 degrees Centigrade. At the end of three weeks the growth which had settled at the bottom of the tube was removed, examined microscopically for purity and placed in a large test tube. The cotton plug was dipped in formalin and reinserted into the tube, which was then sealed with hot paraffin to prevent evaporation of the formalin. After the formalin had been allowed to act at 37 degrees Centigrade for seven days, the culture was removed from the incubator, centrifugalized and washed twice with sterile salt solution, twice with absolute alcohol, and once with ether. The dried mass was then ground in a sterile mortar; ready to be weighed out in any desired quantity for vaccine treatment.

#### PATHOGENESIS

The usual form of actinomycosis or "lumpy jaw" begins somewhere about the oral cavity and extends into the subcutaneous tissues. A localized swelling develops which, in a few weeks, fluctuates and discharges a yellowish green pus. The abscess almost invariably points somewhere upon the skin.

In the pus which exudes yellowish particles can be seen which are known as the sulphur granules.

These granules are characteristic of the disease. They vary considerably in consistency from

<sup>†</sup> Cited from Schlegel M. Strahlenpilzkrankheit Aktinomykose Handbuch der pathogenen Mikroorganismen, V, 1927, p. 41.

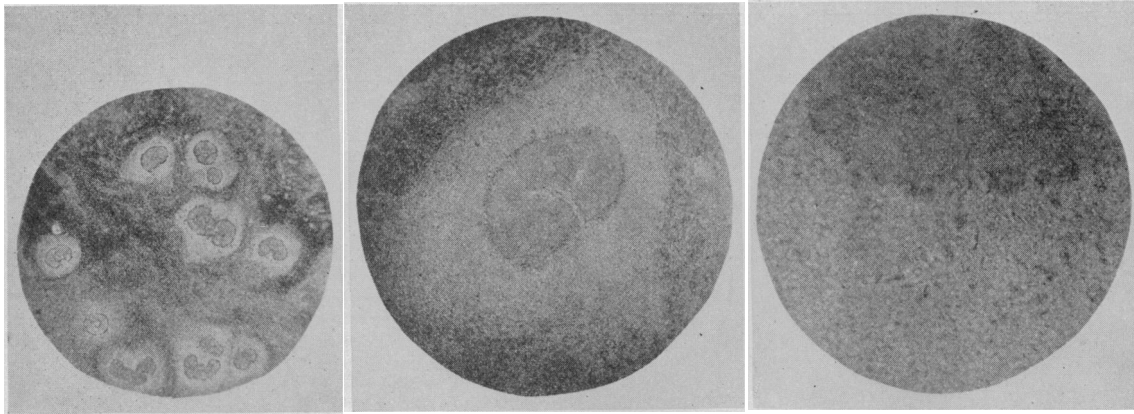


Fig. 1.—Sulphur granules in the pus. Low power.

Fig. 2.—Sulphur granule. High power.

Fig. 3.—club forms.

stony hardness to that of a semisolid fluid. Microscopically the sulphur granule is composed of a central portion made up of closely interwoven myceliae and a periphery of club-shaped forms. (Refer to Figs. 1, 2, and 3.)

Club formation is probably a protective mechanism against the tissue juices. Occasionally particles simulating sulphur granules are seen in discharging sinuses, but they are usually clumps of bacteria.

Sooner or later a second abscess contiguous with the original lesion forms, and during the course of a few months a row of abscesses are present which follow the general direction of the jaw. The lymph nodes are not affected except in the presence of secondary infection. The process rarely metastasizes by way of the lymphatics, but may enter the blood stream causing abscesses in distant parts of the body, such as in the liver or lungs.

The essential pathology consists in a central necrosis of the tissues, a surrounding zone of leukocytes and an outer area of connective tissue. This fibrous layer is ineffectual in preventing the spread of the disease.

#### CLINICAL COURSE

The course of the disease is slow, lasting from one to three years. Occasionally the infection may clear up very rapidly, that is, in a few weeks, or it may be extremely chronic, lasting as long as fifteen years (Sanford and Voelker). The prognosis depends on the region of the body affected. Colebrook<sup>6</sup> states that in ten cases of actinomycosis in the face and neck nine were cured and one died; of eight instances of thoracic infection seven died and one was lost sight of; and of six abdominal cases five died and one is well.

#### TREATMENT

In evaluating any treatment for actinomycosis one must not overlook the fact that certain infections tend to recover spontaneously, particularly those involving the face and neck.

For many years potassium iodid has been considered a specific for the disease. But the drug has proved disappointing in many instances and has frequently failed to check the condition. Even

in very large doses it has had no effect on the course of severe infections. Harbitz and Grondale<sup>7</sup> showed that potassium iodid up to 2 per cent strength in culture media failed to inhibit the growth of *Actinomyces bovis*. Probably the benefit seen with the iodids is simply from their action in aiding the absorption of inflammatory tissue.

As a result of this loss in confidence in the iodids a multiplicity of remedies have been put forward recently, among them being methylene blue, copper salts, roentgen ray, radium, and arspenamin. Many cases have been reported in which vaccine therapy, using a specific vaccine of killed actinomyces fragments, seemed of definite value.

In one of the patients reported here it is of interest to note that the condition did not respond to potassium iodid by mouth, or x-ray therapy combined with surgical drainage of the abscesses, but when the iodid was given intravenously signs of iodism disappeared and the condition improved. Following nonspecific protein therapy, that is, the typhoid, paratyphoid alpha and beta vaccine intravenously, the condition responded quickly with a complete disappearance of all evidence of the disease. There has been no recurrence.

The most effective therapeutic regimen in the type of actinomycosis under discussion probably consists in the use of potassium iodid to tolerance, surgical drainage of the abscesses, small doses of roentgen ray, and the use of foreign protein therapy.

#### REPORT OF CASES

CASE 1.—W. F., age nineteen, white, male, clerk, reported to the out-patient department of the University of California on July 27, 1927. He was referred with a diagnosis of actinomycosis.

*Family History.*—Unessential.

*Past History.*—Lived in California all his life. Clerical work. No contact with cattle. Has occasionally chewed straws. Has had the usual diseases of childhood.

*Present Illness.*—The present illness dates back to November 1926, when a swelling developed over the region of the left mandible. X-ray of the jaw showed an impacted left lower third molar. This tooth was extracted, but the swelling of the left side of the face persisted. A second x-ray showed no bony pathology. In January 1927 the swelling became fluctuant and,

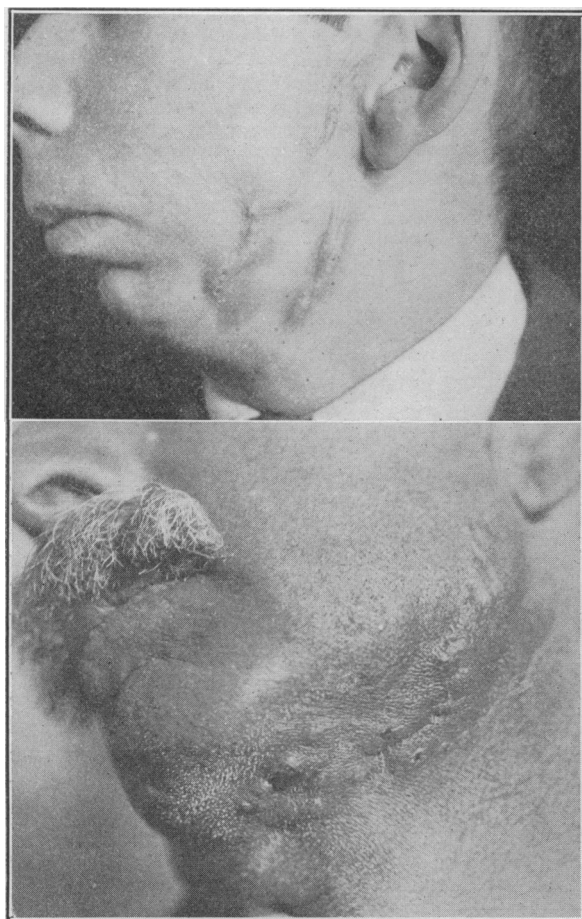


Fig. 4 (Case 1)  
Fig. 5 (Case 2)

upon incision, yellowish green pus was obtained. Examination of the pus showed *Actinomyces bovis*. The patient was placed upon potassium iodid by mouth until he developed a severe iodid acne. The abscesses were drained surgically. For several months the treatment was continued without improvement.

**Physical Examination.**—Negative except for skin condition of left side of face. (Refer to Fig. 4.)

Over the region of the left mandible are several indolent abscesses of a bluish color, fairly deep in the skin and following the general line of the jaw. They vary in length from 2 to 4 centimeters, and all contain yellowish green pus. No enlargement of the neighboring lymph nodes. The oral cavity is entirely negative.

**Laboratory Findings.**—Blood: Hemoglobin, 90 per cent (Sahli); red blood cells, 5,000,000; white blood cells, 8850; polymorphonuclears, 76 per cent; lymphocytes, 22 per cent; large monocytes, 2 per cent.

Urine: Negative.

Stool: Negative for occult blood and parasites.

Blood Wassermann: Negative. Kahn: Negative.

X-ray of left mandible shows no pathology.

Examination of pus obtained from abscesses shows the *Actinomyces bovis* as per Figs. 1, 2, and 3.

Biopsy: Chronic inflammatory reaction. Not distinctive.

Culture: Positive for *Actinomyces bovis*.

**Clinical Course.**—The abscesses were drained repeatedly. Sodium iodid, 20 per cent solution, 10 cc. was given intravenously. From August 3, 1927 to September 29, 1927 he received thirty such injections.

Under this treatment there was very definite improvement, but new abscesses continued to form. On October 17, 1927, the patient entered the University of California Hospital. He received four intravenous

injections of a killed typhoid, paratyphoid alpha and beta vaccine, 75,000,000, 100,000,000, 125,000,000, and 150,000,000 organisms, respectively, at three-day intervals. Following each injection there was a chill and a rise in temperature to 38 to 39 degrees Centigrade. On October 25, 1927, he left the hospital.

In the latter part of January 1928 the patient returned to the out-patient department. He had no evidence of an active infection. There has been no recurrence.

**CASE 2.**—F. M., age fifty-five, resident of Yreka, California. The patient was sent to San Francisco for diagnosis of an infection of the left side of his face. He presented a row of contiguous marble-sized, indolent abscesses following the general line of the jaw. (Refer to Fig. 5.) Upon incision yellowish green pus was obtained which contained large numbers of sulphur granules. (See Fig. 3.) Microscopically these granules proved to be *Actinomyces bovis*. We did not see the patient again. The data are, therefore, not complete.

#### COMMENT

Two classical examples of actinomycosis of the jaw are reported. From one case the *Actinomyces bovis* was cultivated and a specific vaccine was prepared. However, the patient was cured by foreign protein therapy, using a killed typhoid, paratyphoid A and B vaccine before the specific vaccine could be employed.

The iodids are helpful in treatment, but are not specific. When not tolerated well by mouth the drug may be given intravenously without disagreeable effects.

Inasmuch as the causative agent of actinomycosis is not found in nature, the theory that the disease is contracted by chewing straws, grasses, etc., is not well founded, and from a clinical standpoint this hypothesis in many cases does not fit the clinical history.

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#### DISCUSSION

GEORGE D. CULVER, M. D. (323 Geary Street, San Francisco).—Epstein and Shoenholz have so clarified their points in their account of two cases of actinomycosis as to leave little for discussion.

The difficulty of arriving at a specific therapeutic procedure in the treatment of any disease is made greater if the disease is as uncommon as the one under consideration. No individual in dermatology sees many instances of actinomycosis. Frequently the patients disappear without giving the physician a good opportunity to conduct a satisfactory course of treatment.

One might object to the authors drawing such positive conclusions from the one successful case which was apparently cured by foreign protein therapy after

extensive use of sodium iodid intravenously. However, it is to be hoped that any such objection would not cause hesitancy in first choosing the foreign protein therapy in a like instance.

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H. J. TEMPLETON, M. D. (3115 Webster Street, Oakland).—The disapproval by the essayists of the theory that actinomycosis is caused by the chewing of straws, etc., illustrates the point that was recently made in the article, "The Perpetuation of Error in Dermatological Teaching," for this theory has been handed down from textbook to textbook.

In view of the reported excellent results in treatment of blastomycosis and coccidioidal granuloma by means of potassium antimony tartrate intravenously, it might be well to try this drug in actinomycosis.

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ROY W. HAMMACK, M. D. (1003 Pacific Mutual Building, Los Angeles).—The study of the organism in this type of granuloma is interesting though often difficult. While in some cases the organism is readily cultivated by proper methods, in others repeated efforts have, in my experiences, failed. The possibility of this type of granuloma being caused by some other organism than *Actinomyces bovis* is borne out by two cases in my experience. One was clinically actinomycosis of the jaw. Granules were found in the pus from the sinuses and these resembled *Actinomyces*. However, the organism could be readily cultivated aerobically, as was repeatedly shown. Its appearance in cultures was different from that of *Actinomyces bovis*, but it was not definitely classified. Another was a granuloma of the abdominal wall with sinuses in which granules appeared. These granules were much larger than typical *Actinomyces* granules and were brown in color. Microscopically they resembled *Actinomyces*, but efforts to cultivate them failed.

The treatment of these infections is always unsatisfactory and tries the patience of both patient and physician. The use of foreign protein therapy is new to me, but since the results in the case reported were so gratifying I believe it is worthy of further trial.

## RECONSTRUCTION OF LONG BONES\*

By HARLAN SHOEMAKER, M. D.  
Los Angeles

DISCUSSION by E. W. Cleary, M. D., San Francisco;  
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THE fundamental requirement of good orthopedics is perfect equilibrium. When the balance of the body is disturbed through shortening of the long bones of the legs, many compensatory rotations in the pelvis and spine must follow. Reconstruction of a long bone following accident accordingly becomes a matter of great importance to the individual, particularly if that person is within the first three decades of life. A number of factors are involved, and a number of conditions may exist which modify the method of procedure or alter the time of active interference. Multiple fractures, skin abrasions, and shock are chief among these.

I have divided the consideration of the reconstruction of the long bones into the immediate replacement after fracture and the reconstruction of all fractures or malunions.

### IMMEDIATE REPLACEMENT

Immediate replacement of the fractured long bone could include that time up to three weeks

following the injury, as the callus has not sufficiently set to be an obstacle, and the associated injuries to the soft tissues have nearly subsided. Extensive lacerations should delay an active attack upon a bone. An old compound fracture, however, should only be approached nine months after all sinuses have healed and all moisture, however slight, has disappeared.

*Avoidance of Shock.*—The overcoming of muscle and tendon contractures, rotation, angulation, overriding, nonunion, as well as changes in the blood vessels and nerves, are the principal factors that must be dealt with in order to avoid shock with a possible fatal termination.

Muscle and tendon contracture can best be overcome by flexion of the leg at the knee. Gravity at a time when the bone has solidified will greatly aid subsequent treatment to overcome these contractures, and with less pain and less discomfort than the forcible pressure of casts maintaining a strained though correct anatomical position.

Failure to correct rotation of the femur is inexcusable and frequently ridiculous if it were not so disabling. To see a bowlegged workman attempt to climb a ladder with an inwardly rotated malunited femur which throws the flexed knee into a genu valgum illustrates this point. The underlying factors come generally from setting the foot too straight in the cast with an accompanying outward rotation of the upper fragment of the femur.

Angulation is one of the least disturbing factors in union of the femur, and certainly one of the most frequent. If lateral or anterior, the deformity has been accompanied by rupture of the soft tissues in these directions. If the angulation is posterior or inward, and particularly if near the knee-joint, it must be corrected. Pads, wedges and alteration of the case alignment or braces are all useful methods to combat this complication.

Overriding of the long bones should always be corrected. This is most essential in the young. The tiring effect of a waddling gait extends throughout every joint in the body and is evidenced by the lurch of the torso and head.

*Open Reduction.*—If skin traction fails to reduce an overlapping fracture within three weeks, or manipulation under the fluoroscope with moderately forced traction fails to engage a bone, then open reduction is justifiable.

### RECONSTRUCTION OF MALUNIONS

Nonunions are occasionally met with. They are generally encountered when multiple fractures accompany the injury or where serious compounding has occurred. Lack of coöperation of the patient plays a very small part except possibly as regards irregularities in diet with the tendency to overindulge in carbohydrates, particularly the sugars, and failure to take sufficient vitamins in fresh vegetables, fruits, and fruit juices.

Internal fixation may be produced by a foreign body, grafts or plastic work. When muscle tension, angulation or obliquity of the fracture are

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